CHEMICAL & ENGINEERING NEWS

C&EN

SEPTEMBER 26, 1994

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GASOLINE OXYGENATES

Debate focuses on free market versus government mandate
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CHEMICAL & ENGINEERING NEWS

C&EN

SEPTEMBER 26, 1994

NEWS OF THE WEEK

- The U.S. has dramatically improved its competitive position in critical technologies—including materials and associated processing—during the past five years, says a new study. **Page 4**
- Critical Technologies Institute gets new, expanded role under the Clinton Administration. **Page 5**
- The International Union of Pure & Applied Chemistry apparently has acted on the controversy over the naming of transtermium elements 104 through 109. **Page 5**
- Plans announced by Shell Chemical and Huntsman Corp. could increase U.S. annual ethylene capacity by 1 billion lb by late 1996. **Page 5**
- The Environmental Protection Agency adopts a five-year strategic plan based on seven principles and designed to shape the agency's agenda into the 21st century. **Page 6**
- Carbon dioxide emissions must be drastically cut to stabilize atmospheric concentrations at current levels, according to a report by the Intergovernmental Panel on Climate Change. **Page 7**

COVER: Arco Chemical's methyl *tert*-butyl ether (MTBE) plant in Channelview, Tex.

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One year after the project to reinvent government was initiated, federal agencies report successes in cutting red tape. **Page 23**

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The high-resolution x-ray crystal structure of farnesyl diphosphate synthase—a key enzyme in the biosynthetic pathway to cholesterol and other steroids—has been determined. **Page 27**

BOOKS

Carl Djerassi's second "science-in-fiction" novel, "The Bourbaki Gambit," deals with the issue of ageism and conveys to the reader other important aspects of the culture of scientists. **Page 29**

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A recent court decision adds further to the debate on whether the government should mandate use of ethanol as a gasoline oxygenate or whether market forces should be allowed to determine the most cost-effective oxygenate to meet Clean Air Act goals. Page 8

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LETTERS

Regulation strangling business

Albert S. Matlack (C&EN, Aug. 29, page 2) goes to great length to defend the regulatory environment that is strangling U.S. business. He castigates the Business Roundtable for calling the current system costly and inefficient, yet offers no evidence that it is not. He says that "regulation at the federal level has the advantage of providing a level playing field," yet doesn't mention that the level is now so high that anyone without a helicopter can't play the game.

Matlack touts the many jobs and businesses created by the cleanup and one sentence later states, "The main loss in innovation has been the curtailment of exploratory research as a result of corporate downsizing." It apparently doesn't occur to him to question where those jobs were created and why downsizing occurred.

The Fortune 500 company that employs me has had no change in the size of its R&D staff for the last 14 years, but our employment of regulatory compliance staff has exploded. The U.S., with 5% of the world's population, has more lawyers than the rest of the world combined. If we could say the same for our scientists and engineers, we would not be struggling with our balance of trade and could easily focus on solving the problems rather than litigating them.

Robert M. Holdar
Irving, Tex.

U.S. jobs, immigration

I take issue with Kenneth Cohrs' letter (C&EN, Aug. 22, page 5) that strongly implies that there is a direct link between the increase in immigration of highly skilled scientists and engineers and the unemployment rate of U.S. chemists.

Science and technology are highly competitive fields of endeavor that recognize no borders or national or ethnic origins of their practitioners. Highly trained foreign chemists who join our scientific pool tend to stimulate and expand scientific activities. There are countless immigrant chemists, who in the past have made, and many who still are making, significant contributions to U.S. science and technology.

I want to mention just a few contemporary, distinguished immigrant chemists who have been honored by ACS: Sir Derek Barton (Nobel Laureate), Carl Djerassi, Gilbert Stork, Bernhard Witkop, and Alfred Bader (former chairman and founder of Aldrich Chemical Co., known to all organic chemists).

Anyone who reads research articles in scientific journals will notice the numerous exotic, foreign names that represent foreign coworkers and postdocs who are the hands-on workers of so much of this country's academic research. My own experience has been that few U.S. graduates apply for these positions because of poor pay, long hours, and little prospects for advancement. I believe the level of unemployment of chemists in the U.S. during the past couple of years has more to do with the recession, downsizing of defense industries, and insecurity in the pharmaceutical industry than with immigration.

Josef E. Herz
Houston

Federal technology transfer

National laboratories have been under the gun for many years to justify their continued expenditure of huge sums of tax dollars. Most often, "technology transfer" is mentioned as a yardstick of value, but as Wil Lepkowski points out in his recent article, "Federal Labs Examine Strategies for Meeting Technology Transfer Goals" (C&EN, Sept. 5, page 17), "a policy that optimally translates results of publicly funded R&D into competitive industrial products has eluded everyone." One can raise the question of whether there is much technology to transfer.

Department of Energy laboratories in particular have produced only one well-known R&D result: nuclear devices. Although some of this technology was transferred to the private sector (for example, reactors), much was not. Little else in the way of industrial products or new technology has sprung from the vast sums that have been consumed by DOE laboratories over the many years since the Manhattan Project days. The question of how much useful technology is being produced should be examined.

In some cases where there is evident technology to transfer, the DOE bureaucracy has prohibited the realization. An example was the failure of a potentially large-scale transfer of gas centrifuge enrichment technology that was left on the shelf after abandonment by DOE in 1985. Taxpayers spent billions on this already developed enrichment technology that was sought by a private-sector firm to be

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Court Ruling Spurs Continued Debate Over Gasoline Oxygenates

Key point is whether government or market forces should determine use of a particular oxygenate to meet 1990 Clean Air Act standards

George Peaff, C&EN Northeast News Bureau

The debate over gasoline additives has been in progress since the phaseout of lead antiknock additives began in the early 1970s. Mandated by Environmental Protection Agency (EPA) rules promulgated in 1989, octane enhancers that were used to replace lead alkyls began to be used as gasoline oxygenates. And the debate, until now, has largely focused on their health effects, their effects on automobiles, and whether they are as good for the environment as their proponents claim. However, the debate has now shifted to another arena. Put frankly, it is whether the government can mandate a particular oxygenate, in this case ethanol, or whether market forces should determine the most cost-effective oxygenate to obtain the required clean air results.

The U.S. Court of Appeals for the District of Columbia Circuit earlier this month granted a stay on EPA's ethanol mandate. That decision will give full hearing to the debate over the economic, regulatory, and political issues surrounding the reformulated gasoline regulations that are part of the 1990 Clean Air Act.

EPA's decision to mandate by 1996 the use of ethanol and other oxygenates from renewable sources in 30% of reformulated gasoline marketed in the U.S. has resulted in a firestorm. It pits free-market forces and the petroleum industry against government mandates and the ethanol industry, which includes corn farmers who supply the key raw material for making ethanol.

"We are suing EPA because its ethanol mandate is neither legal nor rationally defensible," says Charles J. DiBona, president of the American Petroleum Institute (API).

EPA Administrator Carol M. Browner protests this characterization. "EPA's fuels program reflects the Clinton Administration's commitment toward cleaning the air and reducing summer smog."

The pending case and remonstrance from various sources against EPA's mandate focus on the tax, environmental, and health issues surrounding ethanol and two other oxygenate contenders. One is ethyl *tert*-butyl ether (ETBE), derived from ethanol and isobutylene, and the other is methyl *tert*-butyl ether (MTBE), mainly derived from methane and isobutylene.

The first phase of EPA's ethanol mandate, requiring 15% of reformulated gasoline to contain oxygenates from renewable resources, is scheduled to take effect Jan. 1, 1995, unless the court or Congress overturns EPA's ruling.

Most MTBE makers could readily switch their plants to make ETBE after some production modifications. However, the petroleum industry, represented by API and the National Petroleum Refiners Association (NPRA), have looked to set aside EPA's renewable oxygenate mandate. In July, they petitioned EPA to issue a stay on the ethanol mandate and concurrently filed suit in the court asking it to issue a stay or reverse the EPA rule. The American Methanol Institute (AMI), as representative for methanol producers, joined the suit in August.

In summary, the suit says EPA's original rule "precludes adoption of a [reformulated gasoline] rule without air quality benefits and does not permit a mandate for any particular oxygenate." The suit also says the statute has not considered properly the environmental, economic, energy, and health issues surrounding the ethanol mandate.

In addition, the suit claims that gasoline producers and distributors will suffer "irreparable injury" since they will not be able to recover the added expenses required to meet the mandate and that the five-month lead time to prepare for the mandate is impractical. It also cites that the petroleum industry already uses ethanol in gasoline as dictated by market factors, and that "the ethanol rule is nothing more than a windfall to ethanol producers . . . at the overall expense of gasoline consumers, producers, or both." Because of the 54-cent-per-gal ethanol tax subsidy, the suit claims "hundreds of millions of dollars" will be subtracted from the Highway Trust Fund.

But in late August, EPA denied the petition for a stay, and in its mid-September ruling, the Court of Appeals granted the stay, but did not issue a summary reversal as

Of oxygenates, ethanol offers most oxygen

	ETBE	MTBE	Ethanol	Summer RFG[a], southern grade
Octane rating	112	110	115	88
Blending RVP[b] (psi)	4	8	18	7.2 maximum
Oxygen content (weight %)	15.7	18.2	35	2.0 minimum
Oxygenate % by volume to achieve 2.0 weight % oxygen	12.8	11	5.7	

a. RFG = reformulated gasoline. b. RVP = Reid vapor pressure.
Sources: Arco Chemical, SRI International

asked for by API, NPRA, and AMI. Rather, the court decided to hear the case in early 1995, allowing all parties to present all sides of the case.

Opponents, namely gasoline refiners and distributors and MTBE and methanol producers, claim that market forces should be allowed to determine the most cost-effective product to be used to achieve the oxygenate standards required by the Clean Air Act of 1990. Predictably, these opponents of the mandate welcome the court's decision to hear the case and express confidence the court will decide against the mandate.

Supporters of the mandate point to ethanol as a renewable alternative to MTBE, reducing U.S. reliance on foreign-produced fossil fuels, increasing jobs for corn farmers and ethanol distillers, and cutting farmers' reliance on federal farm subsidies. Predictably, these supporters condemn the court's decision, with EPA saying the court will take the agency's side after reviewing the merits of the case.

Gasoline distribution terminals, such as this one operated by Shell Oil, could be required to blend ethanol with gasoline just before transporting it to gas stations.

Ethanol, as used in gasoline, is mainly fermented and distilled from corn grown by U.S. farmers. Its ether derivative, ETBE, is produced by combining ethanol with isobutylene. MTBE is produced by substituting ethanol with methanol, which is usually derived from natural gas. Although refiners purchase methanol from a number of producers or make it themselves, ethanol must be purchased by refiners and distributors, depending on what form of it is blended into gasoline: straight, as is now the case, or as part of ETBE. The catalysts used to produce MTBE and ETBE also differ, and an ETBE plant would require additional equipment.

The mandate decision emanated from the discussions and hearings held by EPA and the many interested parties involved, including automakers, environmental groups, and the agriculture, ethanol, and petroleum industries. Although the mandate has temporarily been rescinded until a final determination can be reached, EPA has indicated that the reformulated gasoline program will go into effect as scheduled.

But the rocky relationship between ethanol and ETBE and between methanol and MTBE goes back several years, as all four have had dual purposes at various times in various combinations to help achieve EPA's earlier dictate to replace lead-based gasoline additives—tetramethyllead (TML) and tetraethyllead (TEL)—used as octane enhancers in gasoline. Ethanol and methanol at one time were also under development for use as fuel alternatives to gasoline.

In 1973, EPA began the phaseout of lead octane enhancers, and gasoline was allowed to contain no more than 2 g per gal. The agency tightened the restriction in 1986 to 0.1 g of lead per gal, with all lead to be eliminated by 1986.

Before the phaseout of TML and TEL, about 20% by volume of gasoline was made up of aromatics, explains Arthur Zadrozny, manager of government outreach oxygenated fuels at Arco Chemical, a major supplier of both MTBE and ETBE. Aromatics levels reached close to 40% by volume in some grades of gasoline to replace the octane lost with the removal of lead additives, he says.

Beginning in 1989, in an attempt to lower emissions of ozone-producing volatile organic compounds (VOCs) from evaporating gasoline in the summer months, EPA established regulations to reduce the Reid vapor pressure (RVP). RVP is a measure of a liquid's volatility.

In Phase I of the program, RVP was reduced to between 9 and 10.5 psi from May 1 to Sept. 15, with the range determined by geographic area. Nationwide in 1989, RVP of gasoline averaged 11.5 psi.

To meet the RVP reduction program, gasoline producers reduced the amounts of butane blended into gasoline and added more oxygenates along with adjusting reformates and alkylates to make up for the loss of butane. MTBE became the most frequently used octane enhancer. Unleaded regular gasoline usually contains about 0.2% by volume of MTBE, but can range as high as 2.5% by volume, and ranges between 2 and 9% by volume in unleaded premium gasoline.

Phase II of the summer gasoline program was instituted in 1992, but became part of the Clean Air Act amendments. Under the amendments, automotive exhaust emissions of carbon monoxide, nitrogen oxides, VOCs, and toxics including benzene, butadiene, acetaldehyde, and formaldehyde were to be reduced. Again, adjustments to the blending of gasoline were made, mainly leading to the increased use of oxygenates such as ethanol, but primarily MTBE, to meet pollution reduction goals while maintaining octane requirements.

The RVP reduction program's second phase required an average RVP in gasoline of 9 psi in May in 24 southern states; 7.8 psi from June to September in the 24 southern states; and 8.2 psi from May to Sept. 15 in the 26 other states.

In November 1992, the oxygenated gasoline program went into effect requiring gasoline to contain 2.7% by weight of oxygen—equivalent to 15% by volume of MTBE—during the four winter months in the 39 metropolitan regions not meeting EPA's carbon monoxide reduction standards.

The reformulated gasoline program, to be instituted in January 1995, requires nine metropolitan areas with high

Mandate pits farmers against oil producers

Entities against ethanol mandate	Entities for ethanol mandate
American Methanol Institute	Environmental Protection Agency
American Petroleum Institute	Clinton Administration
Exxon	23 farm groups, including National Agricultural Chemicals Association and National Corn Growers Association
Mobil	
National Petroleum Refiners Association	Fuels for the Future
Shell	
Sierra Club	

ozone pollution levels—New York City, Philadelphia, Baltimore, Chicago, Milwaukee, Houston, Los Angeles, San Diego, and Hartford, Conn.—as well as portions of 14 states and Washington, D.C., to meet several standards. Other cities may opt into the program.

Gasoline must have an oxygen content of 2.0% by weight. Benzene content cannot exceed 1.0% by volume. Aromatic content cannot exceed 25% by volume unless benzene content is lower than 1.0% by volume. RVP levels must be 8.1 psi in the northern states and 7.2 psi in the southern states.

Although MTBE, ethanol, and ETBE serve both as octane enhancers and oxygenates, the three have chemical, performance, environmental, and economic advantages and disadvantages depending on what purpose their use takes on.

Ethanol has an octane rating of 115, versus 112 for ETBE and 110 for MTBE. To achieve a 2.0% by weight oxygen content per gallon of gasoline, 5.7% by volume of ethanol would be required versus 12.8% by volume for ETBE and 11% by volume for MTBE.

But use of ethanol raises RVP of gasoline. Ethanol's RVP is 18 psi, compared with 4 psi for ETBE and 8 psi for MTBE. To meet EPA requirements for VOCs, ethanol could not be used in most areas in summertime gasoline. The use of ethanol in gasoline also slightly raises nitrogen oxide emissions as compared with both ETBE and MTBE.

Gasoline containing MTBE has become recognizable—as its concentration in gasoline has risen—by its pungent odor, which has led to consumer complaints in several states. This has also led to further studies on whether MTBE presents a health risk to both its handlers and consumers. While MTBE has undergone several studies to determine its health risks, little study has been done on ethanol and ETBE.

In EPA's latest comprehensive health report concerning MTBE—issued in November 1993—the agency concludes: "There is unlikely to be a substantial risk of acute health symptoms among healthy members of the public receiving 'typical' environmental exposures under temperate conditions (meaning, not subarctic temperatures). This leaves the question open about more subtle health risks, especially among susceptible subpopulations. If acute symptoms are being caused by MTBE, they appear to be mild and transient."

EPA cites several studies (C&EN, Sept. 20, 1993, page 9) conducted on workers and drivers exposed to MTBE in gasoline and MTBE exposure tests in animals. The agency determined that "it does not appear that there is a significant risk for MTBE to cause chronic noncancer effects" by itself, but that when in a mixture with other components in gasoline, the potential noncancer health effects were not known. And EPA also reported, "At the present time and on a tentative basis, there is no reason to say there is a serious carcinogenicity public health hazard from the inhalation of MTBE, although some hazard is possible and necessarily should be further evaluated."

As presented at the American Chemical Society's national meeting in Washington, D.C., last month, a study conducted by the Institute of Arctic Biology at the University of Alaska, Fairbanks, concluded that the gasoline produced for Alaska's 1992 oxygenated fuels program differs from gasoline refined in the lower 48 states. The higher recognition of MTBE odor in Alaskan gasoline, as reported by residents of Fairbanks and other areas, arises because the gasoline originated from North Slope crude and was refined using a different process than gasoline refined in other states.

Using 21 Fairbanks resident volunteers, the study tested six fuels made either from Alaskan or other states' gasoline—both types with 15% by volume MTBE, both with isopropyl alcohol, and both without either MTBE or isopropyl alcohol. Temperatures ranged from –24 to +25 °F to duplicate winter conditions. Odor recognition was eight times that for the Fairbanks MTBE-containing gasoline than for MTBE-containing gasoline from other states. Odors from the two gasolines containing isopropyl alcohol were indistinguishable. The institute also determined that Alaskan gasoline contains "a higher proportion of aromatic compounds than lower 48 fuels" and other states' gasoline "emitted higher vapor concentrations of MTBE across temperatures."

Just as refiners were required to blend MTBE into gasoline to meet Alaska's oxygenated fuels requirement, gasoline refiners and distributors will be required to blend more ETBE or ethanol, respectively, into gasoline distributed to filling stations as a result of the ethanol mandate. Currently, MTBE is the primary oxygenate used because it is the least expensive and is in greater supply than both ethanol or ETBE.

Ethanol poses another problem to refiners, pipeline firms, and distributors. Gasoline using MTBE or ETBE can be blended into gasoline as it is being produced at the refinery and can be shipped via pipeline. Ethanol must be "splash blended" into gasoline just before being transported to a filling station to guard against its hydrophilic properties.

To meet the ethanol mandate, terminal operators would incur costs to transport ethanol to their facilities and they would also have to build additional storage capacity. Refin-

Ethanol ruling shifts oxygenate demand

Millions of gal	1993	2000	% change
Gasoline	113,181	113,779	0.5%
MTBE	3,235	10,854/7,604[a]	236/135
Ethanol	997	2,589[b]	160
ETBE	0	3,249[c]	na

a Represents demand without/with ethanol mandate. b Represents demand with ethanol mandate; without mandate, demand would not change over 1993. c Represents demand with ethanol mandate, including 1.59 billion gal of ethanol required to produce ETBE. **na** = not applicable. **Source:** Probe Economics

Goldberg: try to find joint areas of cooperation

eries would be required to do the same for ethanol intended for ETBE production.

And as explained by Chuck Shepherd, manager of business development and planning for oil products at Shell Oil, Houston, gasoline pipeline operators would face another complexity. "The gasoline blending stock that would be used to mix with ethanol to produce reformulated gasoline ... would be slightly different than conventional gasoline," he says. Gasoline to be mixed with ethanol would have to be blended with a lower RVP.

Currently, gasoline pipeline operators potentially deal with 18 grades of gasoline. Taking into account the three octane levels available, three grades would be of conventional gasoline—which may contain MTBE as an octane enhancer—three grades would contain MTBE serving as the oxygenate, and three grades would have adjusted RVP for ethanol blending. These nine grades double to 18 in order to meet the two sets of RVP requirements for winter and summertime gasoline.

Since most of the ethanol producers are in the Midwest, use of ethanol in gasoline now is restricted to that region because it is cost effective versus piping MTBE-containing gasoline from outside the region. "A number of suppliers have used ethanol in the past as their oxygenate of choice in those markets where it is readily available," confirms Shell's Shepherd.

However, if the ethanol mandate is upheld, because of the ability to ship ETBE-containing gasoline via pipeline, that blend would be added to the 18 grades of gasoline existing, bringing the total to 24 grades of gasoline. "The efficiency of the pipeline operations is something that is of concern and is questionable right now," states Shepherd.

He cites petroleum industry estimates that moving ethanol and installing terminal facilities could add 2 to 4 cents per gal to the price of gasoline, depending on the region the ethanol is shipped to.

Only part of the outcry against ethanol stems from its usage difficulties. "There is something obscene about the argument that a substitute for gasoline that is already subsidized by the taxpayers at more than the total cost of an equivalent amount of gasoline must also have a mandate requiring its use," said API's DiBona in a statement made when API and NPRA filed suit against EPA's ethanol ruling in July.

"The clear winner from the mandate," DiBona said, "is Archer Daniels Midland (ADM). ADM controls two thirds of U.S. ethanol production, and ADM would receive more than half of the money generated by this decision."

ADM is the largest ethanol producer—for use in fuel—in the U.S., with its four plants having combined annual capacity of 700 million gal. Several smaller producers—including Pekin Energy, New Energy Co., South Point Ethanol, A. E. Staley, and Cargill—have a combined annual capacity of 600 million gal of ethanol.

The subsidy API's DiBona refers to actually comes in the form of two tax credits. Under Treasury Department rules, distributors of gasohol, a combination of 10% ethanol and 90% gasoline, can subtract 5.4 cents off their federal excise tax for every gallon of gasohol sold. A 100% ethanol fuel would result in a 54-cent-per-gal excise tax credit. The size of the tax credit drops proportionately to the percentage of ethanol used in gasoline. Various states also have tax credits for the use of ethanol in fuels.

Buyers of ETBE—refiners—could also take a tax credit against their income tax, based on the ethanol content of ETBE. But producers of ETBE cannot take a tax credit for buying ethanol because they are not blending it directly into gasoline.

As explained by Arco Chemical's Zadrozny, ETBE producers pay a premium for ethanol as compared with methanol, and then try to pass the extra cost to the buyer, who gets to take an income tax credit. "Right now, the ether producer must pay the going price for ethanol and then hope to recover this cost in the marketplace," he adds.

However, under the present tax rules, refiners may not be able to take the full tax benefit. "The income tax credit that [the refiners] could realize from using ETBE may be of no value to them because they don't have any tax liability left to credit it against," says Zadrozny. A gallon of ETBE contains 42% ethanol. Using a 10% blend of ETBE in gasoline would result in a potential income tax credit of 2.3 cents per gal of gasoline.

In mid-September, consensus estimates from various commodity chemical and petrochemical consultants placed the spot price for ethanol at $1.25 to $1.30 per gal, MTBE at 90 to 93 cents per gal, and methanol at $1.25 to $1.32 per gal. ETBE currently has no spot price, since its production and use are still in various trial stages.

Arco has taken an "alcohol neutral" position on oxygenated fuels, since it has the capability to produce both ethers. It has U.S. production capacity for MTBE of 800 million gal per year, largest of the 27 current producers. U.S.-based capacity for MTBE totals 3.12 billion gal.

As for ETBE, Arco's Corpus Christi, Tex., plant, leased from Coastal Refining, has a 185 million-gal annual capacity interchangeable for both ETBE and MTBE. Amoco Oil has a test facility for ETBE in place at its Yorktown, Va., site, and Chevron Chemical has a convertible 30 million-gal ETBE/MTBE facility in El Segundo, Calif.

Exxon, Mobil, and Shell, as producers of MTBE, have all come out against the ethanol mandate. "We believe the

ethanol mandate violates the intention of the Clean Air Act to be fuel neutral," says Shell's Shepherd.

A spokesman for Mobil says the company is against government mandates and that the market will determine which oxygenate will be used to meet reformulated gasoline requirements. Mobil has used ethanol in the Phoenix and Minnesota markets, he adds.

And an Exxon spokeswoman says the company "strongly opposes" the mandate. "We believe it is beyond the scope of EPA's statutory authority and is an example of ill-advised government intrusion into the marketplace for the purpose of subsidizing and promoting one specific product over others having identical air quality effects." The spokeswoman adds that the company supports API's challenge in court.

The amount of gasoline to be affected by the mandate has often been distorted by the opposing camps. Backers of ethanol, including EPA, have said only a small portion of gasoline consumed will be made from renewable sources. "In the context of overall gasoline usage, this program will result in only 0.5% of the gasoline consumed annually in the U.S. being made from renewable sources," says EPA's Browner. She refers to the mandate as it is to begin in January 1995, requiring 15% of reformulated gasoline to contain oxygenates from renewable sources.

But the 0.5% is a misleading figure, several sources claim. Whereas 0.5% of the total volume of all gasoline produced in the U.S. would have to contain ethanol, a much greater portion of gasoline would be affected.

"That's a misuse of statistics," explains Zadrozny. "If you take the whole gasoline pool, about 35 to 40% of it is going to be reformulated gasoline." He bases his estimate on looking at the geographic regions where reformulated gasoline must be used and the petroleum industry's projected demand for gasoline in those areas.

A look at gasoline market figures back both Zadrozny and Browner. According to Fred Peterson of Millwood, N.Y.-based Probe Economics, U.S. demand for gasoline in 1993 was 310 million gal per day, or 113 billion gal per year. By 2000, demand is projected at only 312 million gal per day, or 114 billion gal per year, he says.

Looking at MTBE, ethanol, and ETBE as both octane enhancers and oxygenates, Peterson estimates that demand for MTBE in 1993 totaled 8.9 million gal per day, or 3.23 billion gal per year. By 2000, MTBE demand could reach 29.7 million gal per day, or 10.9 billion gal per year. As for ethanol, Peterson projects use in gasoline in 1993 at 2.7 million gal per day, or 997 million gal per year. But with the reformulated gasoline mandate, demand, including ethanol used in ETBE, could rise to 7.1 million gal per day, or 2.58 billion gal per year.

If, in 1995, gasoline demand totals 113 billion gal, under reformulated gasoline requirements 35%—or 39.5 billion gal—would be oxygenated using either MTBE or ethanol. Under the 15% mandate, 5.93 billion gal of gasoline would contain 336 million gal of ethanol to get 2.0% by weight of oxygen within the gasoline. But to get full tax credit for the ethanol used, 10% by volume would be blended, resulting in 593 million gal per year of ethanol used, or 0.5% of the total volume of gasoline, the volume referred to by Browner.

Zadrozny: some tax credits have no value

Kearney, Neb., corn farmer Gary Goldberg, also president of the 12,000-member American Corn Growers Association (ACGA), views the demand for oxygenates from a different perspective. He takes a stand for the greater use of ETBE, citing its lower RVP and ability to be shipped via pipeline. "Right now, [of all] the gasoline pumped in the U.S., only 1% of it is ethanol," he says.

Although admitting ACGA backs EPA's decision, Goldberg says ACGA is unlike some 22 other agricultural organizations, including the 260,000-member National Farmers Union and the 28,000-member National Corn Growers Association, because it is promoting cooperation between the petroleum interests and the ethanol interests. "No other farm organization in America, whether it be a general organization or a commodity group, is talking about ETBE except us. If you were to have the tax credit for ETBE, we believe that we would be able to meet the 15% mandate for 1995 and the 30% [for 1996]."

Goldberg emphasizes that the confrontation between the two sides accomplishes little. "We can fight. We can spend millions of dollars in legal challenges and full-page ads in the *Washington Post*, or we can sit down and say, 'What could we do to try to find joint areas of cooperation?' "

He contends that the long-term interests of the two groups "might not be that far apart. ADM, Staley, and all these ethanol companies do not own their own gas stations. Not one gallon of ethanol would be marketed [for gasoline] if it wasn't a petroleum marketer doing it."

The views of both the agricultural industry and the ethanol industry concerning the reformulated gasoline debate have been distributed by Fuels for the Future, a Washington, D.C.-based information clearinghouse supported by agricultural groups, renewable fuels producers and distributors, consumer organizations, and others. The clearinghouse collects and distributes news concerning clean fuels, clean air, and clean water.

In the months before and after EPA originally set the mandate, each side attacked the other through advertising in various print media and press releases distributed over the various wire services.

By number and content, the ethanol interests, mainly through Fuels for the Future, have been the aggressors in the debate, with the petroleum interests counterattacking. MTBE and its key ingredient methanol were portrayed as poisons and carcinogens if inhaled or drunk, as posing potential health risks, or as perpetuators of the U.S.'s dependence on foreign fossil fuel sources.

API and NPRA jointly, and/or AMI, countered that both methanol and MTBE are poisonous if ingested, may or may not be a cause of cancer, and may or may not cause other

health risks. All three also noted, however, that ethanol, ETBE, and MTBE were approved by EPA as gasoline additives, even as their efficacies were being debated.

Pure ethanol, as used as a gasoline additive, is itself poisonous, as can be the ethanol—in diluted concentrations—in alcoholic beverages. And ethanol, as viewed by EPA, may or may not be a cause of cancer. Gasoline is also poisonous and may or may not be a carcinogen.

A marked illustration of how the two sides portray the issue occurred during the Senate debate of an amendment to prevent funds for implementing the EPA ethanol mandate. The amendment was to be part of the Veterans Administration, Housing & Urban Development, and Independent Agencies appropriations bill for fiscal 1995.

Introduced by Sen. J. Bennett Johnston (D.-La.), the amendment was also supported by Sen. Bill Bradley (D.-N.J.), an outspoken critic of the EPA mandate. It received endorsement from API, NPRA, and AMI.

In separate releases, Fuels for the Future listed 22 farm organizations and five environmental organizations aligned against the amendment. Although the farm organizations were against the amendment but for the mandate, the environmental organizations' opinion on ethanol as an oxygenate was not an issue in their siding against the amendment.

In a letter to various Senators, the environmental groups object to the issues being debated as part of an appropriations bill. "While it is entirely appropriate to have a lively floor debate about those funding choices, we oppose any new proposal to encumber this bill with amendments which are legislation or limitations restricting specific environmental policies," the letter reads. "Whatever the merits of any such proposals, we believe they would be more appropriately pursued through authorizing bills, regulatory procedures, or the courts."

However, Fuels for the Future made no mention as to where the five environmental groups stand on the ethanol mandate. Spokesmen for the Natural Resources Defense Council, National Wildlife Federation, and Environmental Working Group say their groups have no official position on the use of ethanol in reformulated gasoline. Attempts to contact Friends of the Earth were not successful.

The fifth group signing the letter, Sierra Club, has been against the mandate since it was issued. "We see the program as potentially increasing global warming, increasing smog, and increasing air toxics above the levels achieved by the existing reformulated gasoline program," says A. Blakeman Early, Sierra Club's environmental quality program director. "This is a clear example of politics replacing sound policy," he adds.

As for the amendment, it was defeated in a 51 to 50 vote, with Vice President Al Gore casting the tie-breaking vote.

The Clinton Administration clearly stated its position on the ethanol mandate before the vote. In a letter to Senate majority leader George J. Mitchell (D.-Me.), President Clinton said: "I am clearly aware of the attempts by some in Congress to block implementation and enforcement of EPA's rulemaking on renewable oxygenates. I strongly oppose any attempts to interfere with EPA's implementation or enforcement of this rule."

An outside, but by no means neutral, party in the ethanol mandate debate is the automobile industry, led in the U.S. by Chrysler, Ford, and General Motors. All three are opposed to the mandate, but not because of ethanol specifically.

"We are in full support of the formulation, the production, and the use of reformulated gasoline," says Jim Spearot, department head for fuels and lubricants at GM's R&D center in Warren, Mich. The company can design cars to utilize MTBE, ethanol, or ETBE.

He maintains that GM has tried to stay out of the oxygenate argument. "We didn't take sides one way or the other, but indirectly, we support the oil industry position. Our main problem with the whole EPA action in regard to renewable oxygenates is the issue of mandates. Generally, we are a company that supports free-market activities, just as we don't want to see certain types of vehicles mandated."

Says Ronald Peltier, principal research engineer at Ford: "As an industry, the automobile industry has tried to remain neutral in the oxygenate type controversy, but as a company, we have publicly stated that we don't think mandates are proper."

A spokesman for Chrysler says it will meet the guidelines for any fuels as set forth by EPA and the fuel industry.

But as is the case with many of the issues surrounding environmental regulations, new developments stemming from further research and debate could lead to revised, and possibly improved, regulations that satisfy all parties involved. □

Oxygenated fuels program affects many urban areas of the U.S.

Alaska
Anchorage
Fairbanks

Arizona
Phoenix
Tucson

California
Chico
Fresno
Los Angeles-Anaheim-Riverside
Modesto
Sacramento
San Diego
San Francisco-Oakland-San Jose
Stockton

Colorado
Colorado Springs
Denver-Boulder
Fort Collins-Loveland

Connecticut
Hartford-New Britain-Middletown

New York
New York metropolitan area, including northern New Jersey
Syracuse

North Carolina
Greensboro-Winston-Salem-High Point
Raleigh-Durham

Maryland
Baltimore

Minnesota-Wisconsin
Minneapolis-St. Paul

Montana
Missoula

Nevada
Las Vegas
Reno

New Mexico
Albuquerque

Ohio
Cleveland-Akron-Lorain

Oregon-Washington
Grant's Pass
Klamath County
Medford
Portland-Vancouver
Seattle-Tacoma
Spokane

Philadelphia-Trenton-Wilmington metropolitan area

Texas
El Paso

Utah
Provo-Orem

Washington, D.C., metropolitan area, including Maryland and Virginia suburbs

Source: Environmental Protection Agency

German Chemical Industry Welcomes Evidence Of Economic Improvement

■ ***Industry group president Becker sees profitability up in 1994—as a result of higher sales, lower costs, and a better attitude***

Patricia L. Layman, C&EN London

The German chemical economy is finally seeing an improvement after suffering through an abysmal 1993. First-half figures for chemical sales and production are up substantially from last year's first half. And forecasts for the rest of the year indicate continuing growth.

Last year was dismal for both the chemical industry and the overall German economy. In western Germany, overall demand and production for all products fell almost 2%, and gross domestic product (GDP) for the entire country was down 1.25% from 1992, according to statistics from the Economic Survey on Germany for 1993–94, recently published by the Organization for Economic Cooperation & Development (OECD).

The chemical industry was even harder hit. Output was down 3% from 1992 in the 11 states making up the former West Germany and down 5.2% in the five states of former East Germany.

Gert Becker, president of the chemical industry association, Verband der Chemischen Industrie (VCI), and chairman of chemical producer Degussa, said in January: "Nineteen ninety-three turned out to be the most difficult year for the German chemical industry in postwar history."

This year has brought a turnaround for the industry. Chemical sales in western Germany in this year's first half rose 4.2% over last year's first half to $53.3 billion. Through May, sales in eastern Germany were up 3.9% to $1.73 billion.

Production also improved in the first five months of this year. Volumes produced were up 5.1% through May in western Germany, and up 15% in the eastern states. At least one forecast predicts that overall chemical production will grow 3 to 4% per year this year and next, and OECD predicts that Germany's GDP this year will grow 1.75% and accelerate to 2.5% growth in 1995.

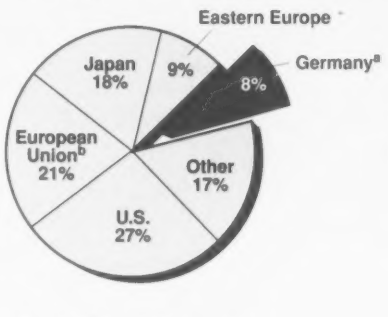
Germany's chemical industry is clearly a world star. According to data compiled by the European Chemical Industry Council (CEFIC), the German industry's sales were worth $98.7 billion in 1993, following only those of the U.S., at $314 billion, and Japan, at $208 billion. And the country fields the world's three largest chemical companies—Hoechst, BASF, and Bayer.

There frequently has been just a hint of smugness in European news stories observing the difficulty of German chemical companies in learning the lessons their international counterparts had to learn in earlier years. Those lessons, in fact, have spurred a joint position paper—issued earlier this month from VCI and from the main chemical labor union, IG Chemie-Papier-Keramik, and sent to leading German politicians—to argue for the reinforcement of the competitiveness of Germany's chemical base.

Competitiveness is now the key issue—and the German chemical industry is addressing the issue thoroughly. One result has been cutbacks in the number of employees in the industry. In 1993, the number of employees in the chemical industry declined almost 5%, to about 556,000—some 29,000 jobs were lost over the course of the year in western Germany. The eastern German chemical industry, meanwhile, employed about 44,000 people at the end of last year—29% fewer than at the end of the previous year. Productivity in the eastern sector, according to Becker, is still only half that of the western German level, so more rationalization measures will be needed.

Since Becker's comments in January, however, things have begun improving. Now, nine months into the year, Becker, in an exclusive interview with C&EN, points out that "some improvements have taken place since the beginning of the year. The economy is improving—sales and volumes are up 4% in the first

Germany has 8% of global chemical sales, 17% of exports



Total 1993 world chemical sales = $1.17 trillion

Total 1993 world chemical exports = $310 billion

a Both eastern and western sectors. b Excluding Germany.
Sources: Verband der Chemischen Industrie, C&EN estimates

six months." Perhaps more important, he adds, "Profitability is up significantly, mainly due to structural redesigning of German chemical companies."

Even beyond those financial measures, however, he sees "an improvement in the psychological environment. We have the feeling that politicians and the public are more and more aware of Germany being increasingly involved in a global competition. The politicians themselves are challenged now to improve the competitiveness of the German nation in every respect.

"These soft facts," he points out, "along with the hard facts of sales and production, definitely can be defined as an overall improvement. Crises can have many good effects, once they are used to bring changes that were unimaginable before."

Some examples: cutting the number of employees and demanding more work for the same salary. The economic crisis, he suggests, is "challenging companies, including German chemical companies, to consider Germany as a 'standort' "—as an industrial base, or country, in which one can do business—"that will maintain its competitive position in the worldwide community, and in worldwide trading."

Moreover, although the economy is improving, Becker says, "changing the structure of the German chemical industry must go on." In many respects, of course, that is easier said than done, because the German industry is "characterized by fully integrated chemical processes. From the beginning, the goal of companies was to find a use for every by-product. Therefore, chemical plants in Germany have been engineered in such a way that one product would find a use across the plant.

"This was of great advantage for the German industry when economic activity was high," Becker says. "But now, imports of basic chemicals and those with higher added value coming from developing countries and China, in particular, are having a dramatic impact on the structure of the German industry. A certain dislocation of products will take place. No longer will every product or every intermediate be produced here. We will have a production network in Europe, in the U.S., and so on, combining our technologies in a way so they are not all here in Germany. This is costly," he points out.

Costly, but necessary, forced by two major developments. The first is the need for the industry to penetrate markets far away from Germany, to be global. "We must bring production to the markets—you cannot serve them from here, given transportation costs and risks," Becker observes.

Becker: our industry has done its homework

The second development is the changing of cost structures. "Costs in Germany have increased dramatically," he notes. "To remain competitive, we must transfer production to countries where production costs are lower than here."

Underlying that trend, he adds, is that the volume of products and sales from German plants is not growing as fast as those outside Germany. "But the administrative costs for running an international chemical company are still here in Germany—central research, central engineering, and so on. The management of a company with its affiliated services, such as accounting and legal, all remain based in Germany, with an increasing volume of costs. The volume of sales to cover these costs is stagnating. The logical conclusion is that we must transfer some of these central costs to where the sales are available to absorb them."

Not all central functions will be split out, he predicts. For example, "I think central research activity will remain in Germany. One of the advantages of the German standort is that we have powerful R&D institutions, with a permanent flow of highly educated scientists. Without any doubt, this is a great advantage for the chemical industry. We will use these scientific potentials as long as possible. But research operations closer to technical assistance or development will be brought closer to the marketplace," he predicts.

For the German chemical industry, however, "the scientific potential is useless if we cannot transfer an idea to product or to technology. If legislation and bureaucratic processes in Germany will not be adapted to the new challenges, the potential we have in Germany will not come to any significant effect. Then the young scientists will go to the places where their ideas will be realized."

A recent article in *Chemie Report*, published by VCI, noted, among other points, that in the field of technology the German chemical industry has had considerable advantages to date, "but this competitive edge is now seriously threatened. Many technologies are today available worldwide and no longer offer a competitive advantage in Germany. And the aggravating factor is that, due to numerous institutional obstacles, the implementation of new technologies takes too much time."

One of the most controversial areas of research for the country's industry is in the biotechnology field. For years, the German chemical and pharmaceutical industries have been lobbying for modification, at the least, of some of the more restrictive regulations regarding biotechnology and genetic research—with mixed success.

In the genetics field, Becker says, "quite a lot of brilliant young frustrated scientists decided to leave Germany and go where the climate is more favorable. This remains a major task for VCI—to speed up all the bureaucratic processes for transferring innovation from labs to production units and to markets.

"We have succeeded in adapting the legal framework for genetic technology to the European level—German legislation has been normalized in line with European legislation. But that still lags significantly behind the U.S. and Japan," Becker says.

The inflexibility of the German legislative process is one of the points mentioned in the position paper written earlier this month by Hermann Rappe, head of IG Chemie, and VCI's Becker. The position paper addresses "the current state and future of the German chemical base—protecting the environment and safeguarding the industry."

The paper presents ideas and proposals to Chancellor Helmut Kohl and other

leaders of the governing and opposition parties. The proposals are intended to "help to jointly find new solutions and bring about their realization in this new legislative period," says a VCI statement.

Among the points made is that "a deeply felt change of values in society has reduced the acceptance of innovations. Subjectively perceived risks outweigh the view that industry and technology create the chances that are the source of wealth."

The paper argues, among other things, that the innovative capability of the German chemical industry "must be strengthened. This above all requires the removal of the existing hurdles to innovation in both the legal and administrative areas. New products and new technologies create replacements for products that are no longer profitable and thus secure employment. Technological advances must be created, built upon, and maintained.

"All those who carry responsibility in politics, the economy, and the sciences must strive hard to strengthen the willingness in our society to once more innovate and change." The paper's authors see the challenge as exceedingly serious: "The German chemical industry is fighting for its international competitiveness, and the clawing back of this position requires a joint effort by the employers, the work force, and the state. Additional burdens cannot be borne under any circumstances—that also applies to the currently much-discussed eco taxes."

The last phrase is the only mention of the carbon tax, or tax on carbon dioxide emissions, in the position paper. But the subject is high on the political agenda in Europe and is fiercely resisted by chemical industry executives there. For example, Jürgen Strube, chairman of BASF, has warned of serious consequences for the country's industrial base if its politicians adopt such an energy tax. "Important [industrial] sectors would have to be relocated abroad, the figures for the economy as a whole will deteriorate, and jobs within German industry will be severely jeopardized," Strube says.

According to Becker, the tax has become a particularly hot political issue because of the country's upcoming elections, scheduled for October. "After October, we may come down to Earth again. The carbon dioxide tax and redesigning of the German tax system to reward ecological steps forward and punish those who hurt the ecology sound very nice—but are very theoretical. In practice, it would be very difficult.

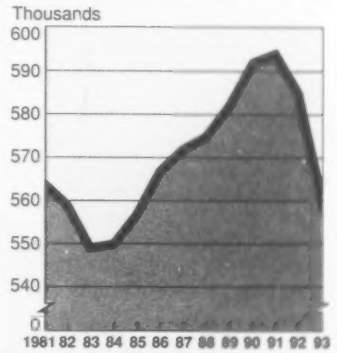
"We will have to talk about this after the elections," he says. "Of course, a carbon tax would punish in particular the German chemical industry, and the result could well be that production with higher carbon dioxide emissions would be transferred to countries with less stringent regulations. Overall, it would not decrease emissions. But in Germany, it would result in loss of jobs, tax revenues, and sales—to cover our central costs."

Becker has noted a change in political and public perception of the chemical industry. He has also noted, and is encouraged by, German chemical companies' changing attitudes toward the public.

"The public has realized that we need chemical operations in Germany, that they are an essential part of the German industry, that the chemical industry is creating jobs and catalyzing innovations. But German companies realize more and more that fears among neighbors and citizens have to be accepted as facts. This feeling is now spreading over the management boards," Becker believes.

One sign of the changing times is that for the first time in the industry's history, major chemical companies are being run by people without a scientific background—by those with a background in economics, law, or marketing, for example. Becker, who started on the commercial side of Degussa 40 years ago, eventually becoming its chairman, says, "I wouldn't say that has triggered a change of mind, but it has triggered public opinion that change is taking place."

Employment drops 5% in western Germany in 1993



Source: Verband der Chemischen Industrie

Among the major issues on his agenda during his presidency of VCI, Becker wants to "emphasize public relations—talk with the public, so it recognizes and accepts the need for the chemical industry to continue to exist," he says.

"We want to make visible to the public that the chemical industry provides the German nation not only with income and exports delivering hard currency but also with innovations, which are necessary to secure the welfare not only of Germany but also of a growing world population. The chemical industry can provide the keys to make the gap between the richer and the poorer in the world narrower." As one example, he cites providing the agricultural sector with plant protection products and with newly developed technology to increase yield, via genetics, to avoid opening up new land for agricultural production—thereby reducing emissions of carbon dioxide.

"We must make clear that the chemical industry has the greatest potential to provide humankind with solutions to feed the population, to protect the environment, and to fight diseases. This is my major point during my two years."

If the industry can do that, he predicts, it will lead to pressure on government and local authorities "to be even more helpful, to support us to continue to be here, to develop new products, and to see that those are developed to generate new jobs and income." It may also help attract young people into the chemical industry. "They will be attracted if they get the feeling they can contribute solutions to the world problems. We are the ones who can make the real contributions, and we need their help. Then they will not shy away from studying chemistry and joining the chemical industry."

According to Becker, "I would like to see the message get across that the German chemical industry has done its homework under the pressure of the crisis. There is still a lot that has to be done, but results so far achieved are increasing our confidence that the core of chemical activity of German chemical companies will remain here.

"If the present process of cutting unnecessary costs, streamlining legislation, and removing unnecessary legal burdens will continue, we can be quite optimistic about the future of the German chemical industry. Optimism is much more creative than pessimism." □